DESCRIPTION

SEPARATOR

Technical field

The present invention relates to a separator designed for use in a stack-type solid polymer fuel cell.

Background art

The need for the effective use of limited energy resources, as well as the need for energy saving to prevent global warming, has hitherto become a matter of public awareness. To date energy needs have been served by means of thermal power generation; that is, by converting heat energy into electric energy. However, considering that coal and oil resources required for thermal power generation are limited in recoverable reserves, the demand for an alternative to such resources has augmented as a natural consequence. As one of new energy resources, attention is being given to a fuel cell for effecting chemical power generation with use of hydrogen for fuel.

A typical fuel cell is composed of two electrodes, namely an anode and a cathode, having sandwiched therebetween an electrolyte. In the cathode, supplied hydrogen is ionized to form hydrogen ion which travels

gas, and coolant.

In the conventional constructions disclosed in JP-A 8-180883 (1996) and JP-A 2002-175818, a gasket is disposed in the vicinity of the separator to prevent leakage of reaction gas and coolant fluid.

As described hereinabove, in the conventional fuel cells, there is a need to interpose a sealing material between the outer periphery of the separator and the cell. Furthermore, in terms of manufacturing process steps, after processing the separator into a desired shape, an additional step is required to fix a sealing material to the outer periphery of the separator or to form a sealing material by means of die molding, with the separator placed as a core.

Disclosure of Invention

An object of the invention is to provide a separator that is excellent in workability and corrosion resistance. Another object of the invention is to provide a separator that allows a reduction in the number of constituent components of a fuel cell as well as a reduction in the number of manufacturing process steps.

The invention provides a separator which is interposed between adjacent ones of a plurality of electrolyte assemblies each constructed of an electrolyte

layer containing an electrolyte medium and a catalytic electrode disposed on a surface in a thickness-wise direction of the electrolyte layer, comprising a separating section for achieving separation between a fuel gas channel and an oxidizer gas channel; and a sealing section disposed along an outer periphery of the separator, for preventing leakage of fuel gas and oxidizer gas, the separating section and the sealing section being integrally formed with each other,

wherein a region corresponding to the sealing section is provided with a sealing projection which is formed so as to extend in parallel with the surface of the electrolyte assembly on which the catalytic electrode is formed, a vertex of which is brought into pressure-contact with the electrolyte assembly under a resilient force, and

a sectional profile of the sealing projection perpendicular to a direction in which fuel gas and oxidizer gas flow is arc-shaped.

According to the invention, the separator is designed to be interposed between the adjacent ones of a plurality of electrolyte assemblies each constructed of an electrolyte layer containing an electrolyte medium and a catalytic electrode disposed on a surface in a thickness-wise direction of the electrolyte layer. The

separator is composed of: a separating section for achieving separation between a fuel gas channel and an oxidizer gas channel; and a sealing section disposed along the outer periphery of the separator, for preventing leakage of fuel gas and oxidizer gas.

A region corresponding to the sealing section is provided with a sealing projection which is formed so as to extend in parallel with the surface of the electrolyte assembly on which the catalytic electrode is formed, a vertex of which is brought into pressure-contact with the electrolyte assembly under a resilient force, and a sectional profile of the sealing projection perpendicular to a direction in which fuel gas and oxidizer gas flow is arc-shaped.

This makes it possible to eliminate the need to prepare a sealing member such as an O-ring or a gasket that has conventionally been required to effect sealing, and thereby reduce the number of the constituent components of a fuel cell and also reduce the number of manufacturing process steps.

The invention provides a separator which is interposed between adjacent ones of a plurality of electrolyte assemblies each constructed of an electrolyte layer containing an electrolyte medium and a catalytic electrode disposed on a surface in a thickness-wise

direction of the electrolyte layer, comprising a separating section for achieving separation between a fuel gas channel and an oxidizer gas channel; and a sealing section disposed along an outer periphery of the separator, for preventing leakage of fuel gas and oxidizer gas, the separating section and the sealing section being integrally formed with each other,

wherein a region corresponding to the sealing section is provided with a sealing projection which is formed so as to extend in parallel with the surface of the electrolyte assembly on which the catalytic electrode is formed, a vertex of which is brought into pressure-contact with the electrolyte assembly under a resilient force, and

a sectional profile of the sealing projection perpendicular to a direction in which fuel gas and oxidizer gas flow is U-shaped or V-shaped.

According to the invention, the separator is designed to be interposed between the adjacent ones of a plurality of electrolyte assemblies each constructed of an electrolyte layer containing an electrolyte medium and a catalytic electrode disposed on a surface in a thickness-wise direction of the electrolyte layer. The separator is composed of: a separating section for achieving separation between a fuel gas channel and an

oxidizer gas channel; and a sealing section disposed along the outer periphery of the separator, for preventing leakage of fuel gas and oxidizer gas.

The region corresponding to the sealing section is provided with a sealing projection which is formed so as to extend in parallel with the surface of the electrolyte assembly on which the catalytic electrode is formed, the vertex of which is brought into pressure-contact with the electrolyte assembly under a resilient force, and a sectional profile of the sealing projection perpendicular to a direction in which fuel gas and oxidizer gas flow is U-shaped or V-shaped.

This makes it possible to eliminate the need to prepare a sealing member such as an O-ring or a gasket that has conventionally been required to effect sealing, and thereby reduce the number of the constituent components of a fuel cell and also reduce the number of manufacturing process steps.

The invention is characterized in that the separating section and the sealing section are formed integrally with each other by means of plastic deformation processing.

According to the invention, since the separating section and the sealing section are formed integrally with each other, it is possible to reduce the number of

manufacturing process steps.

The invention is characterized in that the separator is constituted by a metal sheet.

According to the invention, the separator is constituted by a metal sheet, so that it is possible to perform plastic deformation processing with ease.

The invention is characterized in that the separating section has a plurality of parallelly arranged U-shaped channels positioned in parallel with the surface of the electrolyte assembly on which the catalytic electrode is formed.

The invention is characterized in that the separating section and the sealing section are formed by means of press working.

According to the invention, the separating section has a plurality of parallelly arranged U-shaped channels positioned in parallel with the surface of the electrolyte assembly on which the catalytic electrode is formed. Further, the separating section and the sealing section are formed by means of press working.

Thus, in performing plastic deformation processing on the separator, all that needs to be done is simply to create the channels and the sealing projection.

The invention is characterized in that the sealing projection has, at least in its area to be contacted by

the electrolyte layer, a high polymer elastic layer formed of an elastic body.

According to the invention, the sealing projection has, at least in its area to be contacted by the electrolyte layer, a high polymer elastic layer formed of an elastic body. This helps improve the sealability even further.

The invention is characterized in that the high polymer elastic layer has a width ranging from 1 to 10 mm and a thickness ranging from 1 to 100 μm.

According to the invention, the high polymer elastic layer, although it is formed in a limited space, makes it possible to attain sufficiently high sealability.

The invention is characterized in that two or more pieces of the sealing projections are provided, with their vertices abutted against the electrolyte layer, and that, given that the location of abutment between the vertex and the electrolyte layer is imaginarily indicated by an abutment line, the two or more abutment lines are arranged in parallel with each other.

According to the invention, it is possible to improve the sealability even further.

The invention is characterized in that the separator has an auxiliary projection analogous to the sealing projection formed in the region other than the sealing section and the separating section, and that the auxiliary

projection is disposed in such a way as to make uniform the distribution of contact pressure which occurs between the separator and the electrolyte assembly at the time of assembly of the fuel cell including the separator.

According to the invention, it is possible to avoid any inconvenience such as improper contact which occurs between the separator and the electrolyte assembly due to for example tilting of the separator in the course of assembly.

The invention is characterized in that the separating section is formed of a metal sheet, and the metal sheet has its surface coated with a rubber- or synthetic resin-made coating layer.

According to the invention, the metal sheet has its surface coated with a rubber- or synthetic resin-made coating layer. This makes it possible to produce a separator which is excellent in workability and corrosion resistance.

The invention is characterized in that the coating layer exhibits electrical conductivity.

According to the invention, the coating layer exhibits electrical conductivity, wherefore a DC power generated in the electrolyte assembly can be taken out and collected by way of the separator.

The invention is characterized in that the coating

layer is so formed as to cover the surface of the metal sheet, with an adherent layer or a surface-treated layer lying therebetween.

According to the invention, the coating layer is so formed as to cover the surface of the metal sheet, with an adherent layer or a surface-treated layer lying therebetween. In a case where the adherability of the coating layer and the metal sheet is found to be low, the insertion of the adherent layer or surface-treated layer is effective. The surface-treated layer is formed by removing the oxide film deposited on the surface of the metal sheet or by subjecting the surface of the metal sheet to surface roughing treatment. Through the surface-treated layer thus obtained, the coating layer can be formed on the surface of the metal sheet. Moreover, in the case of using a rubber material to form the coating layer, as an adhesive for use, a triazinethiol- or polyaniline-base compound is desirable. The triazinethiol-base compound is diffused around the surface of the metal sheet, thereby forming the adherent layer. The adherent layer thus obtained allows adhesion of the metal sheet to the rubber material. Another advantage is that the triazinethiol-base compound exhibits electrical conductivity, wherefore the DC power generated in the electrolyte assembly can be taken out

and collected by way of the separator.

The invention is characterized in that in a region of the coating layer which makes contact with the electrolyte assembly is formed a high conductive layer that is higher in electrical conductivity than the coating layer.

According to the invention, it is possible to reduce the contact resistance between the separator and the electrolyte assembly.

Brief Description of Drawings

Other and further objects, features, and advantages of the invention will be more explicit from the following detailed description taken with reference to the drawings wherein:

Fig. 1 is an exploded perspective view schematically showing a polymer electrolyte fuel cell (abbreviated as PEFC) 100;

Fig. 2 is a horizontal sectional view of a unit cell 101 including a separator 1;

Fig. 3 is a view of assistance in explaining the shape of a sealing section 14 designed for generating a resilient force;

Fig. 4 is a schematic view showing the unit cell 101 as seen from a side;

Fig. 5 is an enlarged view of a first embodiment, illustrating the main portion of the sealing section 14;

Fig. 6 is an enlarged view of the first embodiment, illustrating the main portion of a separating section 13;

Fig. 7 is an enlarged view of a second embodiment, illustrating the main portion of the sealing section 14;

Fig. 8 is an enlarged view of a third embodiment, illustrating the main portion of the separating section 13;

Fig. 9 is an enlarged view of the third embodiment, illustrating the main portion of the sealing section 14;

Fig. 10 is an enlarged view of a fourth embodiment, illustrating the main portion of the sealing section 14;

Fig. 11 is an enlarged view of a fifth embodiment,

Thus arranged, the separators 1 with the gas channels allow electric power production.

The substances to be supplied to the flow passage constituted by the channel and the catalytic electrode 21 are not limited to hydrogen gas and oxygen gas, but may be of another substance such as coolant. In the case of using coolant, it is preferable to pass the coolant through both of the channels placed on the opposite sides of the fuel cell 2.

The sealing section 14 is provided with a sealing projection extending in parallel with the surface on which the catalytic electrode 21 is formed. The sealing projection has a U-shaped or V-shaped sectional profile when viewed in a direction perpendicular to the direction in which a gaseous substance flows. A vertex 19 of the sealing projection is brought into pressure-contact with the exposed part of the high polymer membrane 20 under a resilient force. At the position of contact therebetween, sealing is effected to prevent leakage of hydrogen gas and oxygen gas. Moreover, by imparting an inverted U-shaped or inverted V-shaped configuration to the sealing projection, it is possible to reduce the area of contact between the vertex 19 and the high polymer membrane, and thereby achieve a high-pressure sealing effect as achieved in the case of using an O-ring.

In order to bring the vertex 19 of the sealing projection into pressure-contact with the high polymer membrane 20 successfully under a resilient force, the sealing section 14 is formed in a manner such that, when the separator 1 is kept out of contact with the high polymer membrane 20, namely when the PEFC 1 is in its yet-to-be assembled condition, the vertex 19 of the sealing projection extends beyond the position of contact with the high polymer membrane 20 in contrast to the case where the PEFC 1 is in its assembled condition. More specifically, as shown in Fig. 3A, when the PEFC 1 is in its assembled condition, the vertex 19 of the sealing projection assumes a position such that, with respect to a virtual surface A of contact with the catalytic electrode 21, the distance between the vertex 19 and the surface of contact with the catalytic electrode 21 is defined by t1, which is equivalent to the thickness of the catalytic electrode 21. Accordingly, as shown in Fig. 3B, when the PEFC 1 is in its yet-to-be assembled condition, the vertex 19 of the sealing projection assumes a position such that the distance between the vertex 19 and the surface of contact with the catalytic electrode 21 is defined by t2, which is larger than the value t1. Since the junction between the separating section 13 and the sealing

characteristics thereof. The present embodiments are therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description and all changes which come within the meaning and the range of equivalency of the claims are therefore intended to be embraced therein.

Industrial Applicability

As described heretofore, according to the invention, it is no longer necessary to prepare a sealing member such as an O-ring or a gasket that has conventionally been required to effect sealing. Therefore, the number of constituent components of a fuel cell can be reduced successfully.

According to the invention, since the separating section and the sealing section are formed integrally with each other, the number of manufacturing process steps can be reduced successfully.

According to the invention, being made of a metal sheet, it is possible to perform plastic deformation processing with ease.

According to the invention, in performing plastic deformation processing on the separator, all that needs to be done is simply to create channels and a sealing

projection.

According to the invention, the sealing projection has, at least in its area to be contacted by an electrolyte layer, a high polymer elastic layer formed of an elastic body. This helps improve the sealability even further.

According to the invention, the high polymer elastic layer, although it is formed in a limited space, makes it possible to attain sufficiently high sealability.

According to the invention, it is possible to avoid any inconvenience such as improper contact which occurs between the separator and an electrolyte assembly due to for example tilting of the separator in the course of assembly.

According to the invention, the metal sheet has its surface coated with a rubber- or synthetic resin-made layer. The use of such a metal sheet makes it possible to produce a separator which is excellent in workability and corrosion resistance.

According to the invention, the coating layer exhibits electrical conductivity, wherefore the DC power generated in the electrolyte assembly can be taken out and collected by way of the separator.

According to the invention, it is possible to reduce the contact resistance between the separator and the electrolyte assembly.

Claims

1.(Amended) A separator which is interposed between adjacent ones of a plurality of electrolyte assemblies each constructed of an electrolyte layer containing an electrolyte medium and a catalytic electrode disposed on a surface in a thickness-wise direction of the electrolyte layer, comprising a separating section for achieving separation between a fuel gas channel and an oxidizer gas channel; and a sealing section disposed along an outer periphery of the separator, for preventing leakage of fuel gas and oxidizer gas, the separating section and the sealing section being integrally formed with each other,

wherein a region corresponding to the sealing section is provided with a sealing projection which is formed so as to extend in parallel with the surface of the electrolyte assembly on which the catalytic electrode is formed, a vertex of which is brought into pressure-contact with the electrolyte assembly under a resilient force, and

a sectional profile of the sealing projection perpendicular to a direction in which fuel gas and oxidizer gas flow is arc-shaped.

2.(Amended) A separator which is interposed between adjacent ones of a plurality of electrolyte assemblies

each constructed of an electrolyte layer containing an electrolyte medium and a catalytic electrode disposed on a surface in a thickness-wise direction of the electrolyte layer, comprising a separating section for achieving separation between a fuel gas channel and an oxidizer gas channel; and a sealing section disposed along an outer periphery of the separator, for preventing leakage of fuel gas and oxidizer gas, the separating section and the sealing section being integrally formed with each other,

wherein a region corresponding to the sealing section is provided with a sealing projection which is formed so as to extend in parallel with the surface of the electrolyte assembly on which the catalytic electrode is formed, a vertex of which is brought into pressure-contact with the electrolyte assembly under a resilient force, and

a sectional profile of the sealing projection perpendicular to a direction in which fuel gas and oxidizer gas flow is U-shaped or V-shaped.

3.(Amended) The separator of claim 1 or 2, wherein the separating section and the sealing section are formed integrally with each other by means of plastic deformation processing.

4.(Amended) The separator of any one of claims 1 to 3, wherein the separator is constituted by a metal sheet.

5.(Amended) The separator of any one of claims 1 to 4, wherein the separating section has a plurality of parallelly arranged U-shaped channels positioned in parallel with the surface of the electrolyte assembly on which the catalytic electrode is formed.

6.(Amended) The separator of any one of claims 1 to 5, wherein the separating section and the sealing section are formed by means of press working.

7.(Amended) The separator of any one of claims 1 to 6, wherein the sealing projection has, at least in its area to be contacted by the electrolyte layer, a high polymer elastic layer formed of an elastic body.

8.(Amended) The separator of any one of claims 1 to 7, wherein the high polymer elastic layer has a width ranging from 1 to 10 mm and a thickness ranging from 1 to 100 μm.

9.(Amended) The separator of any one of claims 1 to 8, wherein two or more pieces of the sealing projections

are provided, with their vertices abutted against the electrolyte layer, and wherein, given that the location of abutment between the vertex and the electrolyte layer is imaginarily indicated by an abutment line, the two or more abutment lines are arranged in parallel with each other.

10.(Amended) The separator of any one of claims 1 to 9, further comprising an auxiliary projection analogous to the sealing projection formed in the region other than the sealing section and the separating section,

wherein the auxiliary projection is disposed in such a way as to make uniform the distribution of contact pressure which occurs between the separator and the electrolyte assembly at the time of assembly of the fuel cell including the separator.

11.(Amended) The separator of claim 1 or 2, wherein the separating section is formed of a metal sheet, and the metal sheet has its surface coated with a rubber- or synthetic resin-made coating layer.

12.(Amended) The separator of claim 11, wherein the coating layer exhibits electrical conductivity.

13.(Amended) The separator of claim 11 or 12, wherein the coating layer is so formed as to cover the surface of the metal sheet, with an adherent layer or a surface-treated layer lying therebetween.

14.(Amended) The separator of any one of claims 11 to 13, wherein in a region of the coating layer which makes contact with the electrolyte assembly is formed a high conductive layer that is higher in electrical conductivity than the coating layer.

15.(Canceled)

16.(Canceled)

17.(Canceled)

18.(Canceled)